

BACKGROUND

The long-term objective of the U.S. AMLR field research program is to describe the functional relationships between Antarctic krill (*Euphausia superba*), their predators, and key environmental variables. The field program is based on two working hypotheses: (1) krill predators respond to changes in the availability of their food source; and (2) the distribution of krill is affected by both physical and biological aspects of their habitat. To refine these hypotheses a study area was designated in the vicinity of Elephant, Clarence, and King George Islands, and a field camp was established at Seal Island, a small island off the northwest coast of Elephant Island. From 1989-1996, shipboard studies were conducted in the study area to describe variations within and between seasons in the distributions of nekton, zooplankton, phytoplankton, and water zones. Complementary reproductive and foraging studies on breeding pinnipeds and seabirds were also accomplished at Seal Island.

Beginning in the 1996/97 season, the AMLR study area was expanded to include a large area around the South Shetland Islands, and a new field camp was established at Cape Shirreff, Livingston Island (Figure 1). Research at Seal Island was discontinued due to landslide hazards. Shipboard surveys of the pelagic ecosystem in the expanded study area are accomplished each season, as are land-based studies on the reproductive success and feeding ecology of pinnipeds and seabirds at Cape Shirreff.

Beginning in the 1997/98 season, bottom trawl surveys were conducted to assess benthic fish and invertebrate populations. Bottom trawl surveys were conducted in 1998, 1999 and 2001.

This is the 13th issue in the series of AMLR field season reports.

SUMMARY OF 2001 RESULTS

The Russian R/V *Yuzhmorgeologiya* was chartered to support the U.S. AMLR Program during the 2000/2001 field season. Shipboard operations included: 1) two region-wide surveys of krill and oceanographic conditions in the vicinity of the South Shetland Islands (Legs I & II); 2) calibration of acoustic instrumentation at the beginning and end of survey operations; 3) a finfish bottom trawl survey (Leg III); and 4) shore camp support. Land-based operations at Cape Shirreff included: 1) observations of chinstrap, gentoo and Adélie penguin breeding colony sizes, foraging locations and depths, diet composition, breeding chronology and success, and fledging weights; 2) instrumentation of adult penguins to determine winter-time migration routes and foraging areas; 3) observations of fur seal pup production and growth rates, adult female attendance behavior, diet composition, foraging locations and depths, and metabolic rates; 4) collection of female fur seal milk samples for determination of fatty acid signatures; 5) collection of fur seal teeth for age determination and other demographic studies; 6) tagging of penguin chicks and fur seal pups for future demographic studies; and 7) continuous recording of meteorological data.

An oceanic frontal zone was mapped along the north side of the South Shetland Islands, running parallel to the continental shelf break and separating Drakes Passage water to the north from

Bransfield Strait water to the south. The prevailing flow was southwest to northeast; however, both the front and geostrophic flow lines diverged to the north in the vicinity of Elephant Island. The polar frontal zone, identified mostly by sea temperature change and minor salinity variation, was located from underway logged data during all transits to and from Punta Arenas, Chile and the study area. The position of the front during all transits this season was mainly south of the normal range (57-58°S). Chlorophyll concentrations usually increase from Leg I to Leg II; however, this year the opposite was observed. Overall chlorophyll concentrations were on average higher this year in the South Area compared to previous field seasons and lower this year in the West and Elephant Island areas compared to previous years. During both Legs I & II, zooplankton distribution exhibited patterns of mesoscale patchiness. Sampled krill were predominately large and sexually mature with large proportions in advanced female maturity stages. Data from February-March 2001 indicated a normal spawning season due to significant larval krill concentrations. Large proportions of juvenile and immature krill indicated a large recruitment of the 1998/1999 and 1999/2000 year classes. During February 2001, krill abundance in the Elephant Island area was relatively high compared to previous years. Salps showed a curtailed production season, which was indicated by the length-frequency distribution of the dominant aggregate stage. Salp abundance decreased 60% between Legs I & II in 2001 and was due to the loss of large aggregates from the upper water column. This might suggest an early downward migration prior to production of overwintering solitary stages. Copepods and larval krill dominated the zooplankton assemblage and although salps were widespread, their relative abundance decreased dramatically throughout the survey. This, and other aspects of the zooplankton assemblage, suggested that 1999, 2000 and 2001 may be classified as transition years from a salp-dominated community to a copepod-dominated community. Copepod abundances were among the highest in 2001 in the Elephant Island area. This coupled with reduced salp abundance and favorable krill spawning suggest improved larval production and survival and thus possible successful krill recruitment in 2002. Acoustically detected layers of myctophid fish and krill were mapped during Legs I & II. Myctophids tended to occupy the offshore regions of the shelf whereas krill tended to be found in the onshore regions of the shelf.

The bottom trawl survey was designed to collect data in support of an ecosystem-based assessment of finfish within the 500m isobath of the South Shetland Islands. A total of 7,238kg (17,581 individuals) of 44 fish species were processed from 71 hauls in the South Shetland Island region. Species that were caught in substantial numbers, defined as >500kg or >500 individuals, included *Notothenia coriiceps*, *Gobionotothen gibberifrons*, *Champscephalus gunnari*, *Chaenocephalus aceratus*, *Chionodraco rastrospinosus*, *Gymnoscopelus nicholsi*, and *Lepidonotothen larseni*. The species with the greatest yield in weight was *Notothenia coriiceps* (2,296kg, 1,752 individuals) and the species with the greatest catch in numbers was *Champscephalus gunnari* (778kg, 4,318 individuals). This information is used for management of finfish resources in the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) in this area.

The benthic invertebrate community was highly patchy on a scale between 1.3 and 4.5nm. Individual tows were strongly dominated by a single taxon, but there was no obvious correlation in biomass, abundance, or dominance with depth or geographical location. However, sponges were mainly found around Elephant Island whereas seastars were found around the southern

South Shetland Islands. Acoustic volume backscattering strength sample data were collected for seabed classification purposes. Seabed class descriptions were based on images and sediment samples resulting from the ground truthing methods. Most samples were mixtures of sediments varying from silt, mud, dense clay, sand, gravel, pebble, cobble, to boulder. Future analyses are planned to describe the entire bottom habitat surrounding the South Shetland Islands based on data collected during this survey.

A total of 7,212 chinstrap and 1,043 gentoo penguin pairs bred at Cape Shirreff during the 2000/01 season. Penguin populations have been censused at Cape Shirreff annually since 1997/98. The 2000/01 population counts represent the lowest chinstrap penguin count on record, while the gentoo penguin census was the highest population count to date. Mean chinstrap and gentoo penguin clutch initiation dates coincided exactly with dates in 1999/00. Chinstrap penguin reproductive success in 2000/01 was within the four-year range; however, the survival of chicks from hatching to fledging was the highest ever recorded. Gentoo penguin reproductive success was also within the four-year averages. A total of 9,744 chinstrap and 1,298 gentoo penguin chicks survived to crèche age this breeding season. For both species, this season represented the largest number of chicks counted at Cape Shirreff in five years. The dominant prey species in all diet samples was krill (*Euphausia superba*), which we found in 100% of samples from both chinstrap and gentoo penguins. Chinstrap penguin diets consisted solely of krill, whereas gentoo penguins ate both krill and fish. Analysis of the length-frequency distribution of krill in the penguin's diets revealed that over 90% of all krill in the samples were from three CCAMLR size classes: 46-50, 51-55, and 56+mm. These krill are believed to be from the strong 1994/95 cohorts that have dominated the diets of the penguin species at Cape Shirreff for the last 4 years. Similar to the previous three seasons, the 2000/01 season foraging pattern displayed a bimodal distribution. This season, we observed a 2-hour decrease in the duration of short-trips, and a >1 hour decrease in the duration of long trips compared to the 1999/00 pattern. The average duration of foraging trips was the shortest in four years.

The median date of fur seal pupping at Cape Shirreff based on pup counts was two days earlier this year than in 1997/98 and 1998/99 and pup counts increased by 6.8% over last year. Although return rates for adult females were slightly lower than the previous year, a 90.2% over-winter survival in 2000/01 is still high and there was no change in arrival condition compared to last year. Return rate for yearlings was higher this year than last. Adult female trip duration for the first six trips to sea was significantly less than in previous years indicating improved foraging conditions. Fur seals this year had slightly more krill in the diet than last year and the overall percentage of fish in the diet was lower. An increasing percent occurrence of fish and squid as the season progresses was present as in previous years. Teeth were extracted from 60 lactating female fur seals for age determination and other demographic studies. Preliminary studies of the effect of tooth extraction on survival, natality, and attendance behavior indicates that there no measurable significant differences.

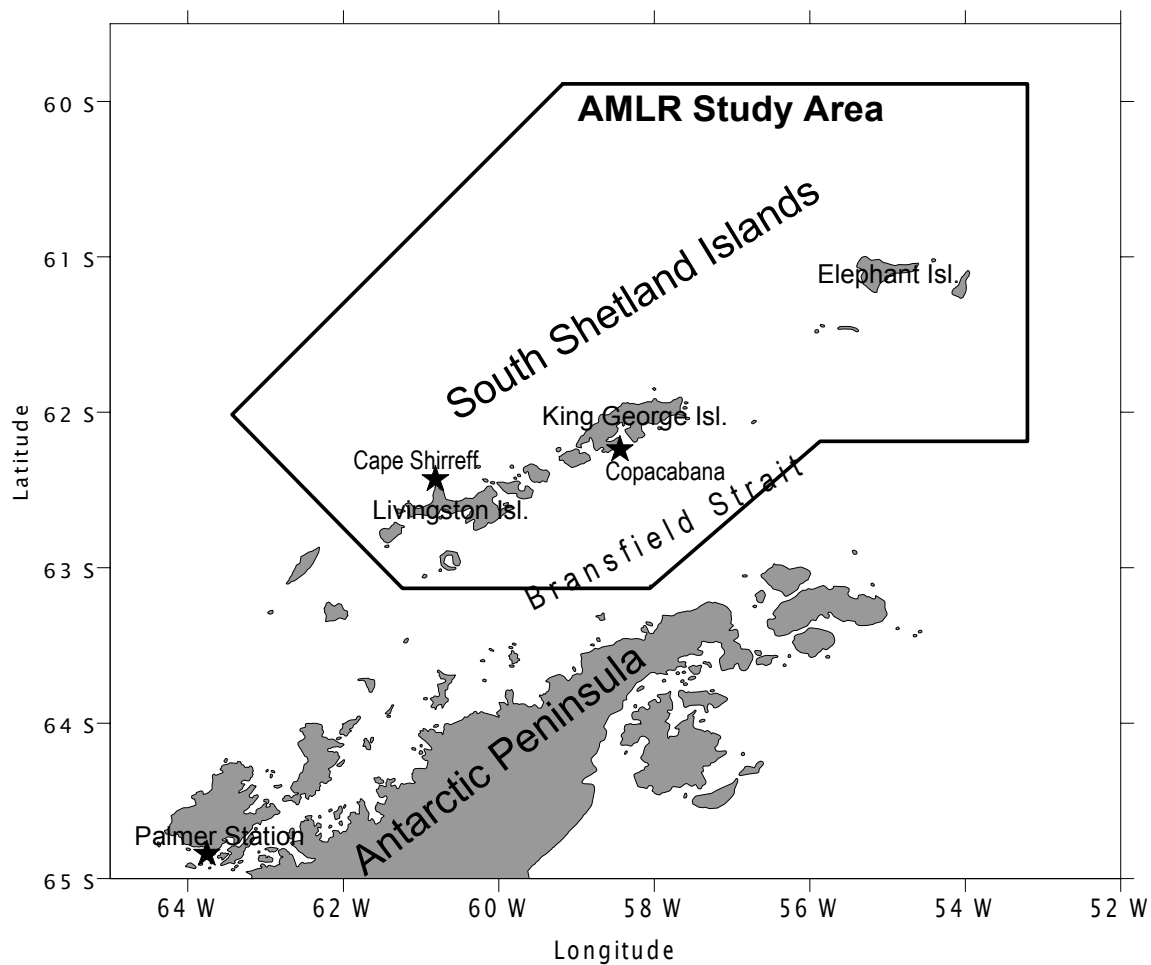


Figure 1. Locations of the U.S. AMLR field research program: AMLR study area, Cape Shirreff, Livingston Island and Copacabana, King George Island, Antarctica.